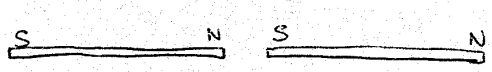
Pink

10. (15 pts) Two identical bar magnets of length 26 cm and square pole face of area 0.08 cm^2 have magnetization $M = 0.8 \times 10^6$ A/m. Determine their pole strengths. If the magnets are placed in a line, with the N pole of one 5 cm from the S pole of the other, estimate their force of attraction. Estimate the field that ~~the large~~ one N pole makes at the S pole of the ~~smaller~~ other. Briefly explain your reasoning.



$M = \frac{\mu}{V}$, so $\mu = MV = MA\ell = (0.8\times10^6 \frac{A}{m})(0.08 cm^2)(0.26m)$

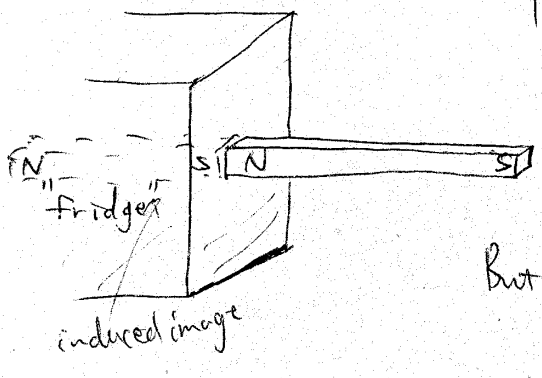
$= 1.664 A\cdot m^2$ $\quad 1.664 A\cdot m^2$

Also $\mu = q_m \ell$, so $q_m = \frac{\mu}{\ell} = \frac{1.248 A\cdot m^2}{0.26m} = 6.4 (A\cdot m)$

$|\vec{F}| = \frac{k_m q_m^2}{r^2} = \frac{(10^{-7}\frac{N}{A^2})(6.4 A\cdot m)^2}{(0.05m)^2} = 1.638\times10^{-3} N$

$|\vec{B}| = \frac{k_m q_m}{r^2} = \frac{(10^{-7}\frac{N}{A^2})(6.4 A\cdot m)}{(0.05m)^2} = 2.56\times10^{-4} T$

11. (15 pts) A 14 cm long permanent magnet has a 0.25 cm-by-0.24 cm cross-section. Its north pole is placed against a refrigerator door (made of 'soft' iron). A force of .0056 N is required to pull the magnet off the door. Estimate its magnetization (magnetic moment per unit volume). Briefly explain your reasoning.



Treat the poles as sheets.

$|\vec{F}| = q_m |\vec{B}_{q_m}| = (\sigma_m A)(2\pi k_m \sigma_m)$

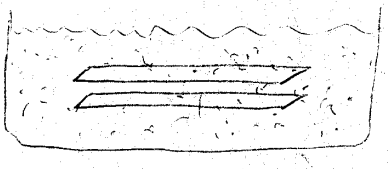
$= 2\pi k_m A \sigma_m^2$

$\Rightarrow \sigma_m = \sqrt{\frac{F}{2\pi k_m A}} = 3.857\times10^4 \frac{A}{m}$

But $\sigma_m = \frac{q_m}{A} = \frac{q_m \ell}{A\ell} = \frac{\mu}{V} = M$.

So $M = 3.857\times10^4 \frac{A}{m}$.

12. (10 pts) A parallel plate capacitor of area 140 cm^2 and plate separation 2.4 mm is immersed in a bath of insulating fluid. For a charge of ± 56 nC there is 127.7 V across the plates. The breakdown voltage is 3.6×10^5 V. Find the dielectric constant and the breakdown field.



$C = \frac{Q}{\Delta V} = \frac{56\times10^{-9} C}{127.7 V} = 4.38\times10^{-10} F$

But also $C = \frac{KA}{4\pi k d} = K \frac{140\times10^{-4} m^2}{4\pi \cdot 9\times10^9 \frac{N m^2}{C^2} (2.4\times10^{-3} m)}$

$= K(5.16\times10^{-11} F)$.

$\Rightarrow K = \frac{4.38\times10^{-10} F}{5.16\times10^{-11} F} = 8.502$.

$E_{breakdown} = \frac{\Delta V_{breakdown}}{d} = \frac{3.6\times10^5 V}{2.4\times10^{-3} m} = 1.5\times10^8 \frac{V}{m}$.